Background

Forests cover ~31% of the continental U.S. Human management practices impact all forests. When forest management is incorporated into models, it often relies on stand scale assumptions that are not evaluated at the regional scale. The effect of forest management on biodiversity, land surface biophysics, and biogeochemistry has not yet been credibly incorporated into continental-scale Earth system models (ESMs).

Objectives

• Quantify the impact of forest management and disturbance on biodiversity, biogeochemical cycling, and climate regulation at plot to macrosystem scales
• Develop a framework for assessing the role of spatial and temporal scaling of stand-level hypotheses to regional domains in ESMs.

Research Hypotheses

1) Management is the strongest driver of forest structural change. Ecological forest management will result in greater spatial variation in stand canopy cover, structural complexity and diversity than production forestry
2) When scaling from stand to region, forest management type influences the magnitude of non-linear divergence in C cycling. Type and magnitude of non-linearity will be a function of forest management type. An ontology of management will create a framework for non-linear scaling, regardless of forest type.

Analyses of stand level carbon

CENTURY based model - modified for simulation of repeated partial harvesting (PH1 and PH4) and clear cut (CC1) scenarios.

Result: Partial harvesting hastens recovery time and still leads to long-term carbon storage. Long-term net ecosystem exchange of carbon is a better metric of carbon cycle response to harvest type than the short-term effects, which tend to show net emissions.

If stand-level forest management influences temporal dynamics of carbon storage, how will a mosaic of non-synchronous stand-level management practices influence regional carbon dynamics?

How do climate, management, and disturbance interact with forest ecosystem function at regional to continental scales?

How can we improve fundamental theories linking forest structure to function at the macrosystem scale?

Next Steps

• Map management, disturbances, and environmental characteristics.
• Expand the Fourier Transform BFAST analysis to various spatial scales
• Categorized forest management approaches: conventional/production forestry, ecological forestry passive management, wilderness/preservation
• Modify The Ecosystem Demography 2 (ED2) Model parameters to generate estimates of forest structure characteristics under management scenarios.
• Investigate if the macrosystem behaves as the aggregate of the mosaic of different stages of succession, management, and disturbance scenarios.

Challenges

• Spectral signal analysis is computationally intensive
• Choice of algorithm to deal with poor-data MODIS pixels
• Generate hypotheses/analyses appropriate to regional/continental level

Broader Impacts:

Improve ecological theory of succession
Inform forest management
Use management simulations to evaluate forest feedbacks on climatic patterns

Future Directions

This project will develop a conceptual framework with tools and theoretical developments for macrosystem analyses of forest management. We will:

• Map the link between regional ownership and management,
• Analyze historical trends in the phenotype of forests subject to different management approaches, and
• Establish the collaborative and methodological environment necessary for developing and refining regional-scale hypotheses in a Category 2 study

Pilot Study - Management in the signal

Spectral entropy of signal

Number of breaks in signal

Private Plantation harvested in 2003 and replanted

Private plantation harvested in 2007 and NOT replanted

Federal Land– natural repeated burning 2007 and 2010

Average Normalized Spectral Entropy

Average Breaks in Spectral Signal

PnET-CN simulation of ~100 y mixed hardwood forest with partial harvests every 15 y at varied intensities.

Result: Partial harvesting of < 34% stay as a carbon sink for the majority of the time period (600 y) while harvests of >34% are still carbon sources at 600 years.

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